research bulletin 22

THE CITY'S AIR QUALITY

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Introduction

The public's awareness of the dangers of air pollution has been heightened in the last 12 years by regular media reports of the "air pollution index" as well as press reports on lead emissions and potential health hazards caused by airborne contaminants. Adding to this general awareness of air quality is odour pollution which is familiar to many City residents and frequently thought to be linked with health threats and ineffective air quality controls.

The Residents Attitude to City Services (RACS) survey, carried out by consultants in mid–1981, revealed the extent of City residents' concern about air pollution. Approximately 30% of the respondents thought air pollution was a very serious problem. In addition, between 50% and 80% of respondents wanted the City to do more in stopping air pollution even though they were expressly reminded this would mean spending additional tax dollars.

The purpose of this Bulletin is to answer some of the questions frequently asked by citizens regarding air pollution and to state the simple facts of the problem as it applies to the City of Toronto.

What's In the Air and Its Effects

Smoke, dust and odours from fuel and refuse burning are readily recognized as common air pollutants. Less well known are gases which are invisible and odourless such as hydrocarbons from motor vehicles and a multitude of vapours and oxides.

Chart I summarizes what are considered to be the main air pollutants along with their general effects. It can be seen that air pollution affects man and his urban environment in various ways: as a hazard to human health; as a threat to vegetation; by damaging man-made materials and property; and by diminishing the aesthetic value of recreational and environmental amenities.

Sources of Air Pollution

The City of Toronto experiences air pollution generated from within and from outside its boundaries.

Other than industrial upset situations which occasionally occur, the major sources of pollution are odours and particulates, both suspended and fallout. Raw resources (meat by-products, oil , grain), processing (brewing, refining, incineration), handling (sugar, oils), storage (gasoline) and industrial housekeeping (garbage, decomposing grain) contribute to the odour problem. The major City road/rail transportation corridor (the Gardiner/Lake Shore/CNR/CPR Lines), as well as an assortment of industries and utilities significantly contribute to suspended particulates, especially lead and hydrocarbons.

Air Quality Monitoring

Air quality monitoring is done by the Ministry of Environment at almost 1,000 locations across Ontario. The most well known air pollution monitoring system is referred to as the "air pollution index". It is based on a 24-hour average concentration of sulphur dioxide and suspended particulate matter and has been ongoing in the City since 1970.

Another air pollution monitoring system uses stations which measure ambient (surrounding) air quality. Three of these stations are located in the City of Toronto: one at Wellesley and Yonge, one near Front and Sherbourne and the third in the Junction Triangle area. Substances measured at these locations include hydrocarbons, sulphur dioxide, nitrogen dioxide, carbon monoxide, ozone, particulate matter and lead. The results of these measurements are made public on a regular basis.

Other types of air monitoring stations operated by the Ministry of Environment and scattered throughout the City include:

(a) "high volume air samplers", measuring specific contaminants, (e.g. asbestos, lead); and

(b) "dustfall stations" — passive samplers providing data on airborne dust and particulate matter.

The City — Specific Results of Air Monitoring

Figures 1–9 summarize quantitative air quality data obtained by the continuous monitoring instruments operated by the Ministry of Environment in the City. The results are discussed below.

Air Pollution Index (Figure 1) — At an air pollution index of 32, with continued adverse weather conditions expected, certain offending industries are alerted to the problem and may even be asked to curtail operations. At an air pollution index of 50, the Minister of Environment has the power to order curtailment and if the index exceeds 100 a shut-down can be ordered. Figure 1 reveals that the 50 level has only been exceeded in the City five times since 1970, while the 32 advisory index has been

Figure 1
Downtown Toronto: Air Pollution Index (API)

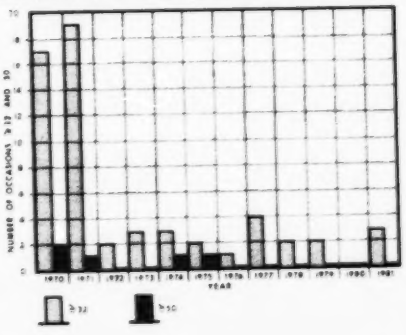


CHART 1

Primary Air Pollutants and Their Effects

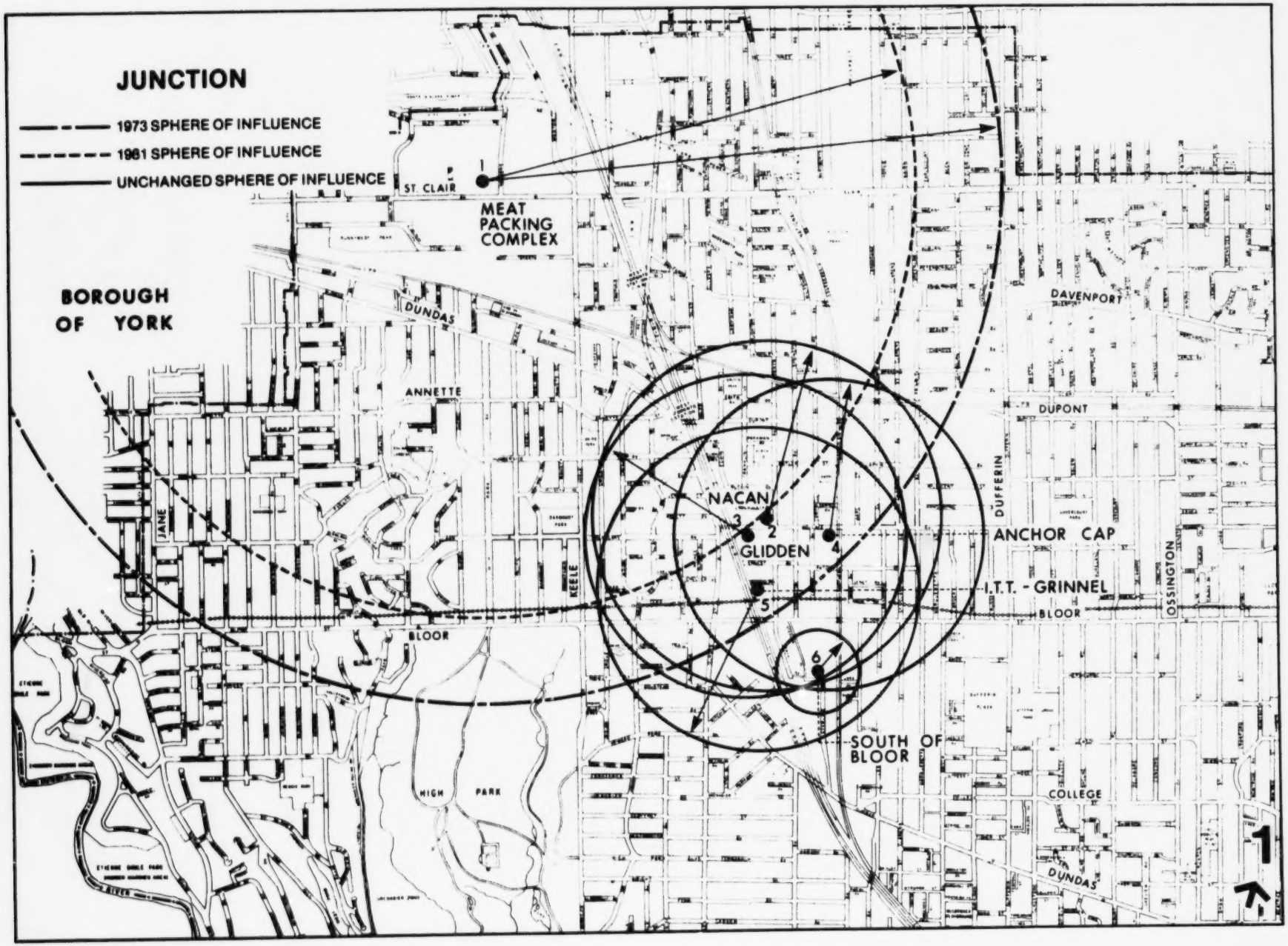
Pollutant	Effects
CARBON MONOXIDE (CO) Colourless, odourless, tasteless gas, about 97% as heavy as air.	Humans: When CO enters bloodstream, it interferes with ability of blood to transport oxygen, thus impairing nervous system. At high concentrations, kills quickly. Concentration of 100 parts per million (ppm) which can occur in heavy traffic, can cause dizziness, headache, lassitude, other symptoms of poisoning and (similar to excessive alcohol or fatigue) may be a traffic hazard. 30 ppm for 8 hours or 120 ppm for one hour can be serious health risk to sensitive people (e.g. with heart disease, asthma).
SULPHUR OXIDES Chemical compounds of sulphur and oxygen, principally: SULPHUR DIOXIDE — SO(2) Colourless gas with pungent, irritating odour at concentrations of above 0.3 ppm. SULPHUR TRIOXIDE — SO(3) Gas which combines with water in the atmosphere to form sulphuric acid.	Humans: SO(2) can irritate upper respiratory tract. If absorbed on particulate matter or converted into sulphuric acid, can be carried deep into the lungs where it can injure delicate tissue. Prolonged exposure to low levels of SO(2) has been associated with increased deaths due to cardiovascular disease in older persons; to higher levels, increased deaths due to respiratory disease, and school children's complaints of cough and mucous membrane irritation. Very heavy concentrations intensify these effects. Plants: Sulphur oxides damage trees and other plants especially grains, alfalfa, grapes, white pine and apples. Other: Also attack and destroy building materials including steel, zinc, paints, nylon and stone. High concentrations coupled with high humidity reduce visibility and create transportation hazards.
NITROGEN OXIDES Compounds of nitrogen and oxygen, principally: NITRIC OXIDE (NO) Colourless gas, relatively harmless but convertible to NITROGEN DIOXIDE — NO(2) Gas, normally brownish-red in colour. In presence of sunshine, acts as trigger for photochemical reactions resulting in smog.	Humans: Poorly understood. 13 ppm may cause eye and nose irritation. Higher concentrations indicated lung damage in animals. See photochemical oxidants (smog). Plants: Nitrogen oxides restrict plant growth; injuries similar to SO(2).
HYDROCARBONS Compounds of hydrogen and carbon. Major polluting hydrocarbons are those resulting from incomplete combustion of fuels and evaporation of fuels and industrial solvents. Exist in air primarily as gases (methane, ethylene, acetylene, etc.). Benzo-a-pyrene is a solid particulate.	Humans: Most hydrocarbons toxic only at high concentrations. Considerable number, including benzo-a-pyrene, have produced cancer in animals (one study found that breathing city air is equivalent to smoking 7 to 36 cigarettes per day, depending on the concentration). Even at low concentrations certain hydrocarbons react with sunshine to produce smog.
PHOTOCHEMICAL OXIDANTS Chemical compounds — major components of smog. Formed when hydrocarbons and nitrogen oxides are exposed to sunlight. Most significant oxidants are ozone and peroxyacyl nitrates (PAN).	Humans: Eye irritation, difficulty breathing, particularly for those with respiratory diseases. Ozone (at levels common to cities) irritates mucous membranes in nose and throat. Higher concentrations produce coughing, choking and severe fatigue. In smog, ozone interferes with lung function, causes bronchial irritation, coughing and sore chest; also reduces visual acuity and causes recurrent headache, fatigue, chest pains, difficulty breathing. Long-term exposure shortens life of experimental animals. Plants: Smog also causes lesions in plant leaves, thereby causing serious decline in agricultural crops. Ozone is toxic to forage and field crops, shrubs, trees, particularly conifers. Materials: Ozone damages textiles, discolours dyes, accelerates cracking of rubber. Visibility: Smog can reduce it to a quarter of a mile. Also hazardous for airplane operations.
PARTICULATES Any matter, liquid or solid, dispersed in the air with individual particles smaller than 500 microns (about 1/50 of an inch) in diameter. May remain airborne from a few seconds to months. Includes aerosols, visible particles, fumes, soot.	Humans: Some particulates are directly poisonous or disease-producing (e.g. arsenic, asbestos, fluorides, lead). Others multiply the potential harm of irritant gases. Still others speed chemical reactions in the atmosphere, thereby producing much more harmful substances (e.g. certain particulates speed the conversion of SO(2) to sulphuric acid).
LEAD Metallic element, a natural constituent of soil, water, plant and animal life. Taken into the body in water, food and air. Most air pollutants are in the form of aerosols, fumes and powders.	Humans and Animals: A cumulative poison. One form damages brains of young children, may cause death. Other forms may cause severe malnutrition, general weakness, impaired functioning of nervous system, sometimes paralyzing forearm.
ODOROUS COMPOUNDS Offensive smells which provoke complaints about air pollution. Hydrogen sulphide is a prime offender.	Humans: Nausea, headache, loss of sleep, loss of appetite, allergic reactions, emotional disturbances. Property: Discouragement of improvement, damaged community reputation, stifled community growth, decline in property values, loss of tax revenue and jobs.

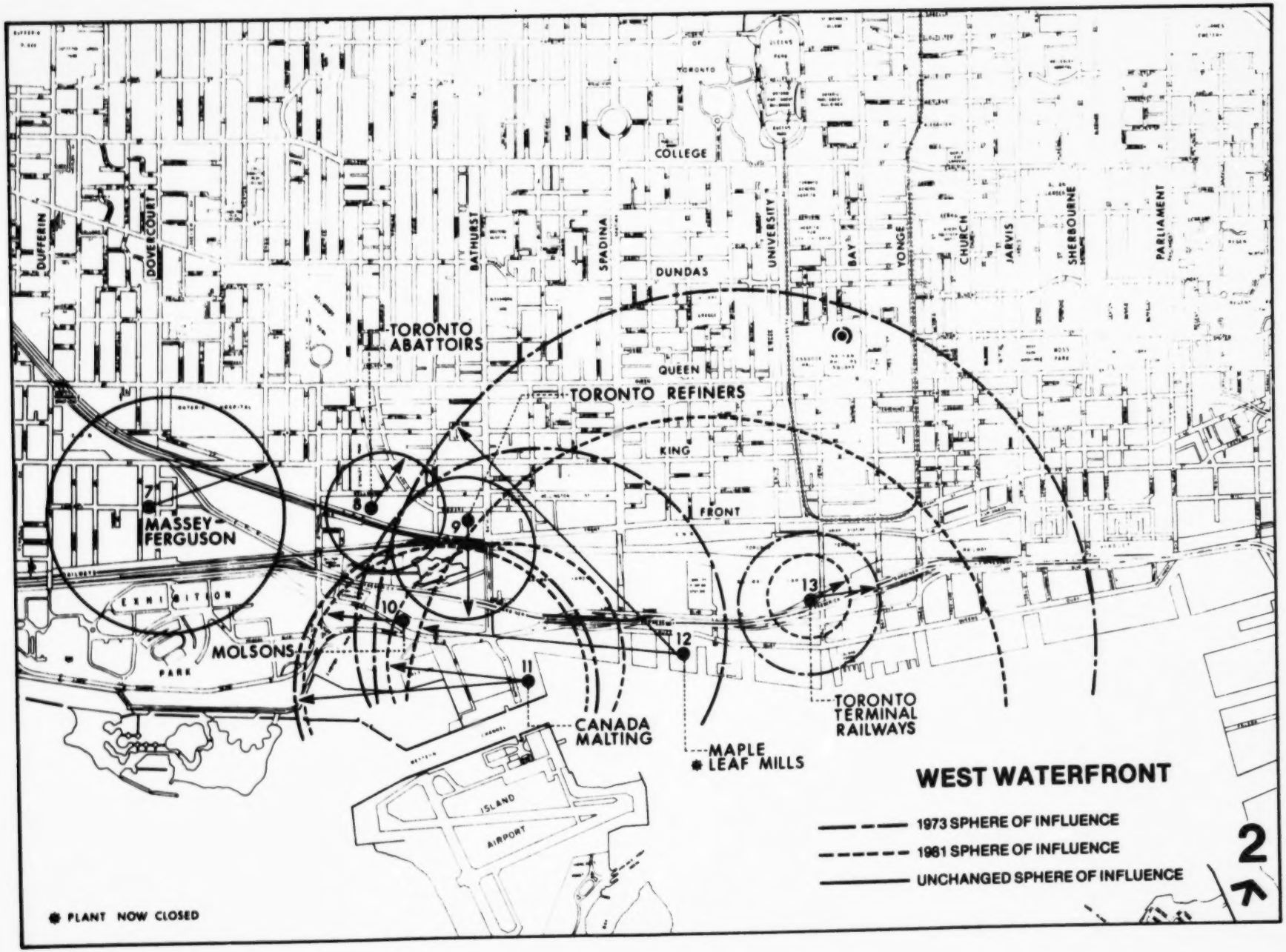
Source: Oakville Environmental Report, Reg Lang and Audrey Armour, 1977

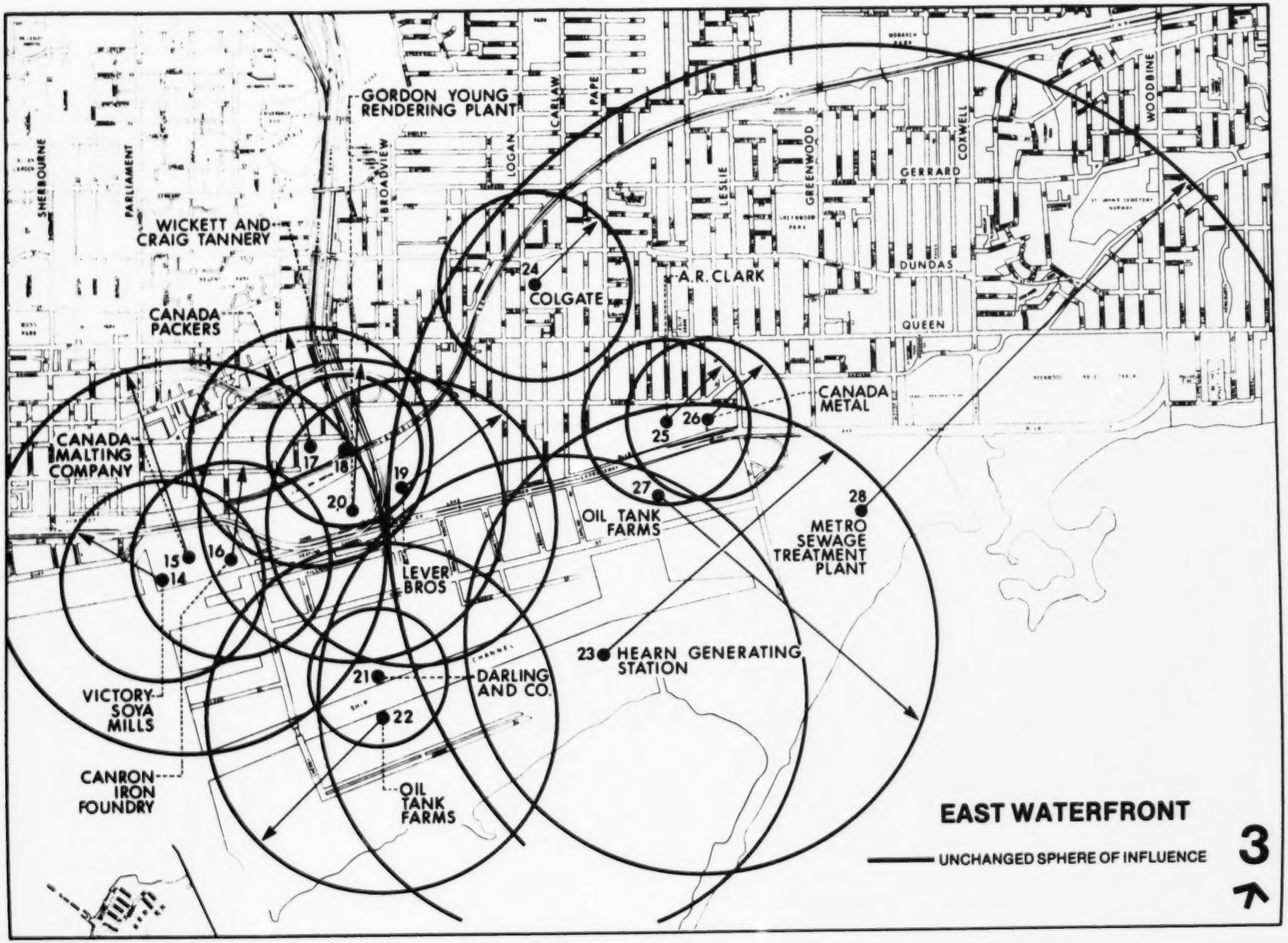
CHART 2
Local Industrial Emissions

Source	Major Emissions	Corrective Measures
1. Meat Packing Complex (Canada Packers, Swifts, etc.)	Odour	Corrective action underway since 1974. Residential odours under adverse weather conditions and upsets.
2. Nacan	Odour	Under correction.
3. Glidden	Odour	Under correction.
4. Anchor Cap	Odour	Being evaluated.
5. ITT-Grinnel	Odour, Dust	Under correction.
6. South of Bloor (n/w area)	Odour, Dust	No current problems, but potential problems if zoning changes.
7. Massey-Ferguson	Industrial Odour	Not a current problem.
8. Toronto Abattoirs	Odour	Good operation and housekeeping essential to minimize odour problem.
9. Toronto Refiners and Smelters	Sulphur Dioxide Lead	Emissions are within acceptable limits.
10. Molsons Brewery	Odour	Odour control equipment appears effective.
11. Canada Malting (west plant)	Dust	Control equipment has been installed.
12. Maple Leaf Mills	Dust, Odours	Plant now closed.
13. Toronto Terminal Railways Boilerhouse	Nitrogen Oxides	Stopped burning coal, therefore, eliminating sulphur dioxide.
14. Victory Soya Mills	Dust, Odour	Improved truck loading measures. Additional baghouses installed. Further improvements scheduled.
15. Canada Malting (east plant)	Dust, Odour	Ministry of Environment negotiating for installation of complete control equipment.
16. Canron Iron Foundry	Particulates, Odour, Smoke	Fume incinerator installed. Further improvements are anticipated.
17. Canada Packers	Sulphur Dioxide	Scrubber on sulphonating plant appears effective.
18. Wickett and Craig Tannery	Odour	Two new waterwash paint spray booths installed.
19. Lever Detergents	Odour	New particulate control equipment installed. Temporary problems may result with new sulphonating plant.
20. Gordon Young Rendering Plant	Odour	Reduction in all plant odour sources. Further improvements underway.
21. Darling and Co. Rendering Plant	Odour	Under study
22. Oil Tank Farms	Odour	Petroleum storage reduced by 60% since 1972.
23. R.L. Hearn Generating Station	Sulphur Dioxide Particulates, Oxides of Nitrogen, Dust	Increase in coal usage since 1970's, but dust from coal piles has been reduced.
24. Colgate	Odour	Equipment problems cause odour on occasion. Some new control equipment installed.
25. A.R. Clark Co. Tannery	Odour	Control order being negotiated. Some odourous operations have been discontinued.
26. Canada Metal Co.	Lead, Sulphur Dioxide	Effective control equipment is now installed.
27. See 22		
28. Metropolitan Toronto Main Treatment Plant	Odour	Aeration tanks are now covered and the 600 foot stack is complete. Technical problems with stack causing delay in effective use.

Source: Ministry of Environment, Air Resources Branch


JUNCTION
1973 SPHERE OF INFLUENCE
1981 SPHERE OF INFLUENCE
UNCHANGED SPHERE OF INFLUENCE
ST. CLAIR
MEAT PACKING COMPLEX
BOROUGH OF YORK
DUNDAS
ANNETTE
JANE
KEELE
BLOOR
HIGH PARK
DAVENPORT
DUPONT
DUFFERIN
OSSINGTON
NACAN
GLIDDEN
ANCHOR CAP
I.T.T. - GRINNEL
SOUTH OF BLOOR
COLLEGE
DUNDAS
1
2
3
4
5
6


COLLEGE
DUFFERIN
DOVERCOURT
BATHURST
SPADINA
UNIVERSITY
BAY
YONGE
CHURCH
JARVIS
SHERBOURNE
PARLIAMENT
DUNDAS
QUEEN
KING
FRONT
TORONTO ABATTOIRS
TORONTO REFINERS
MASSEY-FERGUSON
EXHIBITION PARK
MOLSONS
CANADA MALTING
MAPLE LEAF MILLS
TORONTO TERMINAL RAILWAYS
ISLAND AIRPORT
7
8
9
10
11
12
13
WEST WATERFRONT
1973 SPHERE OF INFLUENCE
1981 SPHERE OF INFLUENCE
UNCHANGED SPHERE OF INFLUENCE
PLANT NOW CLOSED
2


GORDON YOUNG RENDERING PLANT
SHERBOURNE
PARLIAMENT
BROADVIEW
LOGAN
CARLAW
PAPE
LESLIE
GREENWOOD
COXWELL
GERRARD
WOODBINE
DUNDAS
QUEEN
WICKETT AND CRAIG TANNERY
CANADA PACKERS
24
COLGATE
A.R. CLARK
CANADA METAL
CANADA MALTING COMPANY
17
18
19
20
25
26
27
28
OIL TANK FARMS
METRO SEWAGE TREATMENT PLANT
15
14
16
LEVER BROS
23
HEARN GENERATING STATION
21
DARLING AND CO.
22
VICTORY SOYA MILLS
CANRON IRON FOUNDRY
OIL TANK FARMS
EAST WATERFRONT
UNCHANGED SPHERE OF INFLUENCE
3

exceeded an average of two to three times a year. According to the air pollution index, significant improvements in the City's air quality have occurred since 1971.

Total Suspended Particulates and Soiling Index (Figures 2 and 3) — Traditionally, the public identifies air pollution with black or dark smoke. This is caused by suspended particulate matter comprised of particles of smoke from combustion and dust from construction and transportation. Total suspended particulates are measured in terms of the number of micrograms of suspended particulate matter per cubic metre of air. The soiling properties of a sample of suspended particulate is known as the soiling index.

Both contaminant indexes reflect the fact that improved combustion technology and the increasing use of fuels other than coal have diminished smoke and dust as major pollutants. The annual average soiling index criterion has not been exceeded since mid-1971 while the average annual total suspended particulate levels are only slightly above acceptable levels.

Figure 2
Downtown Toronto: Total Suspended Particles (TSP)

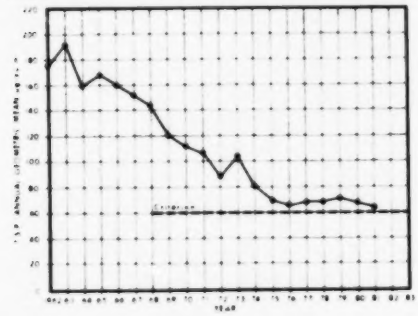
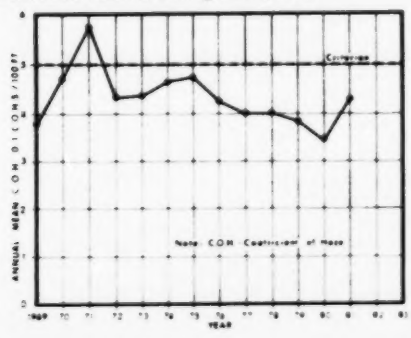


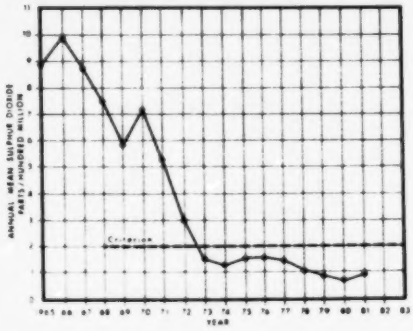
Figure 3
Downtown Toronto: Soiling Index (COH)



Sulphur Dioxide (Figure 4) — Coal fired thermal generating stations are the largest source of SO(2) in southern Ontario. Other significant contributors include coke ovens, residential fuel users, refineries and other industrial operations. In the long term, however, community air quality is more a function of local, continuous sources of pollution than large and distant sources emitting from tall stacks.

SO(2) levels in the City have been well below the Ministry of Environment's annual average criterion since mid-1972, for reasons similar to those cited above pertaining to diminished levels of suspended particulate matter.

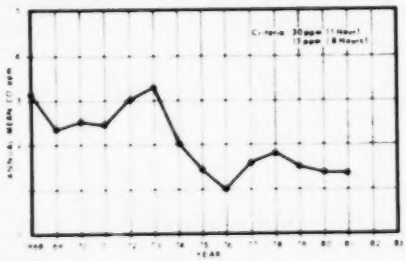
Figure 4
Downtown Toronto: Sulphur Dioxide (SO_2)



Carbon Monoxide (Figure 5) — In terms of total weight and concentration, carbon monoxide is the most prevalent contaminant in the City's air. Cars and trucks are almost exclusively responsible.

The 1981 carbon monoxide annual mean of 1.25 ppm (parts per million) is well below the one-hour criterion of 30 ppm and the eight hour criterion of 13 ppm in addition to being lower than annual means in the early 1970s. Automobile pollution control equipment has achieved this improvement, which would be even more marked if the number of vehicles on City streets had not substantially risen in the late 1970s.

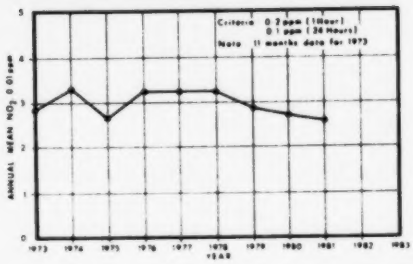
Figure 5
Downtown Toronto: Carbon Monoxide (CO)



Nitrogen Dioxide (Figure 6) — No evidence exists that nitric oxides (NO) at concentrations measured in the atmosphere are harmful to human health. Nitrogen dioxide, which results from photochemical oxidation of nitric oxide, is however, known to affect health and human vision. The main sources of nitrogen oxides are power plants, automobile exhausts, incinerators and chemical processes.

Figure 6 indicates that there has been little variation in the concentrations of NO(2) in the City's atmosphere since 1973. Annual mean levels are well below one hour and 24 hour criteria.

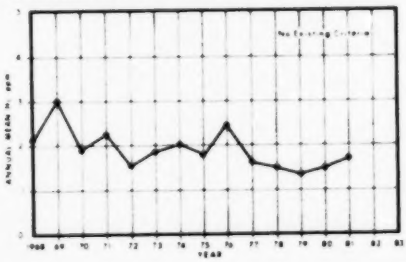
Figure 6
Downtown Toronto: Nitrogen Dioxide (NO_2)



Total Hydrocarbons (Figure 7) — Hydrocarbons are emitted both by natural sources and man-made sources such as vehicles and industries. Of particular interest are the non-methane fractions of the total hydrocarbons which react with nitrogen oxides and sunlight to form ozone and other oxidant chemical species common in the Los Angeles type smog. Non-methane hydrocarbons are known as reactive hydrocarbons.

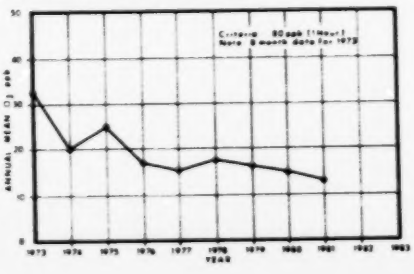
No criterion has been set for either total or reactive hydrocarbons in Ontario. Amounts of total hydrocarbons in the City air have varied from an annual mean high of 3.0 ppm experienced in 1969 to a low of 1.3 ppm in 1979.

Figure 7
Downtown Toronto: Total Hydrocarbons (Hc)



Ozone (Figure 8) — In the upper atmosphere, ozone is a natural constituent which plays an important role in the maintenance of life by absorbing harmful ultra-violet radiation. In the lower atmosphere, however, it is a secondary product of photochemical reactions between reactive hydrocarbons and nitrogen oxides and is detrimental to the health of man and plants.

Figure 8
Downtown Toronto: Ozone (O_3)

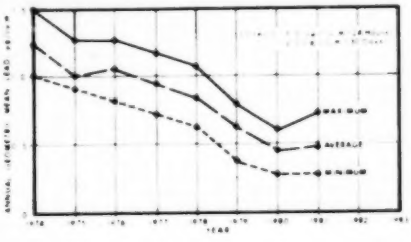


Interestingly, ozone concentrations in Ontario are highest in rural areas because time is needed to create ozone which means it is usually found some distance from its initial source. Figure 8 indicates that ozone levels have been steadily decreasing in the City and are not anywhere near the one hour criterion.

Lead (Figure 9) — Ambient air lead is a human toxicant which varies temporally and spatially in an urban environment. Highest accumulations can be found adjacent to lead smelters and heavily used transportation corridors.

The maximum, average and minimum annual geometric mean ambient air lead concentrations in the City have been drastically reduced between 1974 and 1981 due to the combination of no-lead gasoline and direct lead smelter abatement actions taken by the Ministry of Environment.

Figure 9
Toronto: Ambient Lead Concentration
Based on 5 Station



Local Industrial Pollution

Maps 1, 2 and 3 show the location and general spheres of influence for the 28 main sources of pollution in the City. Most of these sources are in lands zoned as industrial. The boundaries are based on the knowledge and experience of Ministry of Environment staff. To a large extent, they reflect the limits of citizen complaints pertaining to odour emissions from a particular source.

In certain cases, such as the Toronto Railway (Map 2), two separate spheres of influence are depicted. One refers to what the sphere of influence was in 1973 when the maps were initially created, while the other refers to the sphere of influence shown on 1981, updated versions of these same maps. Diminished spheres of influence can be attributed to effective corrective measures to reduce emissions, especially odours.

For the majority of industries, the 1973 and the 1981 spheres of influence are the same. This does not imply that no measures have been taken to reduce harmful emissions from these sources. In many instances this has occurred, but has had no discernible effect on the extent of emitted odours. Chart 2 explains types of emissions by source for each industry shown on the map and lists corrective actions that have been or will be undertaken.

Climate

The data in this bulletin clearly show that under normal conditions, air pollution levels in the City of Toronto are usually well below the levels considered damaging to human health. Pollution buildup, however, can be worsened considerably by occurrence of a condition known as temperature inversion, where temperature increases with height rather than registering the usual decrease. During an inversion, which usually happens in late fall, vertical mixing and turbulence are restricted, confining contaminants to a thin layer of still air near the ground. If the condition persists for more than 48 hours, pollution levels begin to increase from acceptable levels toward potentially hazardous concentrations.

It is for this reason the policies are being proposed for the Official Plan (including special policies for the Central Waterfront area) on maintenance of air flow, especially the lake breezes. Implementation of these policies will occur during the design phase of new major buildings on the waterfront and in the downtown.

Further Considerations

While urban air pollution is less severe in the City than in the past, there are still problems. First, the standards for air pollution are open to question. The relationship between a particular level of pollutant and a given effect is often quite tenuous, making the standard arbitrary, which opens up the possibility of defining away an air quality problem by raising the standard. These uncertainties are revealed by the differences in standards among jurisdictions, although generally the Ontario standards are stricter than those for the federal level in the United States and Canada. Second, there is the long distance factor over which the City has little direct control. Increasing amounts of long distance pollution can be expected from the United States due to a series of very regressive amendments to the U.S. Clean Air Act in August 1981. Negotiations between Canada and the United States pertaining to this issue, particularly the acid rain problem, have so far proven unsuccessful.

Conclusion

The City's air is significantly cleaner than it was in the 1960s. The introduction of automobile air emission equipment, the redevelopment of the Waterfront and the shift away from coal burning have contributed to declines in levels of suspended particulate matter, sulphur dioxide, carbon monoxide, hydrocarbons, ozone and lead.

Surprisingly little of this air quality improvement can be attributed to reductions in emissions from local, existing industries. Odours, in particular, are very difficult to control and appear to be no better in 1982 than they were a decade ago. The likelihood of long distance air pollution getting worse makes it that much more important that the City:

(a) continue to use its available powers to minimize local pollution; and

(b) keep abreast of the results of ongoing air quality monitoring so that changes can be picked up before they become major problems.

Thanks to officials at the Ontario Ministry of Environment for their assistance in producing this bulletin.

For more information call Ed Mihalcin at 947-7185.